DRAWING AMENDMENT

Please replace FIG. 3 of the drawing on file with the hereto attached Replacement Drawing (1 sheet).

<u>Remarks</u>:

This amendment is submitted in an earnest effort to advance this case to issue without delay.

The specification has been amended to eliminate some minor obvious errors. No new matter whatsoever has been added.

Enclosed herewith is a corrected FIG. 3 that shows

The main claim has been replaced with a US-style main claim that clearly defined the instant invention over the prior art.

US patent 3,961,780 of Sag is not relevant because it refers to an indexing system where the minimum resolution is given by the difference between the pitch of one tooth of the first toothed element of the first coupling and the pitch of one tooth of the second toothed element rf the first coupling. In fact in US '780 the inner wheel has 360 teeth each of 1° while the outer wheel has 400 teeth each of 0.9°, and the minimum resolution is (1 tooth X 1°)-(1 tooth X 0.9°) = 0.1°.

On the contrary, US patent 4,463,488 of Pieczulewski, as in our invention, the minimum resolution is given by the difference

between the pitch of more than one tooth of the first toothed element of the first coupling and the pitch of more than one tooth of the second toothed element of the first coupling. For example if the inner wheel has 125 teeth each of 2.88° while the outer wheel has 288 teeth each of 1.25°, the minimum resolution is (53 teeth X 1.25°)-(23 teeth X 2.88°) = 0.01°.

One of the main differences between the present invention and US '488 is how they provide high accuracy machining. US '488 refers exclusively to a work table with indexing apparatus. From US '488 one can clearly appreciate (FIGS. 6 and 7) that the orientation of the treatment head having the spindle 214 for the cutter 212 is always fixed and the machining accuracy depends on the tilting angle of the table top 224 obtained by means of wedges 234, 236.

The present invention makes possible high accuracy machining with a treatment head having a special indexing apparatus. None of the above-cited US patent references discloses the concept of obtaining high accuracy machining by adjusting the treatment head with a special indexing apparatus. One skilled would not be encouraged to transfer to a treating head the teaching of equipping a work table with an indexing apparatus due to the fact that in general a work table and a treatment head work in a very different condition. i.e. the first one works in a static condition (the workpiece is kept fixed when machined) and the

second one works in a dynamic condition (the tool has to rotate for machining the workpiece).

Thus the instant invention as defined in the amended claims is clearly allowable under §102 and §103 over the cited art.

If only minor problems that could be corrected by means of a telephone conference stand in the way of allowance of this case, the examiner is invited to call the undersigned to make the necessary corrections.

Respectfully submitted,
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Enclosure: Request for extension (one month)
Corrected version
Substitute Specification
Replacement drawing (1 sheet)

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~~CONNECTION DEVICE BETWEEN MEMBERS OF A MACHINE~~

INDEXABLE MOUNT FOR A TOOL HEAD

DESCRIPTION

CROSS REFERENCE TO RELATED APPLICATIONS

This application is the US national phase of PCT application PCT/EP2003/006369, filed 17 June 2003, published 31 December 2003 as WO 2004/001249, and claiming the priority of Italian patent application MI2002A001352 itself filed 19 June 2002 whose entire disclosures are herewith incorporated by reference.

FIELD OF THE INVENTION

The present invention refers to a ~~connection device~~ mount between members of a machine.

BACKGROUND OF THE INVENTION

In particular, hereafter reference shall be made to ~~connection devices~~ mounts of the type usually used for example in machine tools for ~~the connection of~~ supporting and orienting a rotary head or else a rotary table. In other examples, such ~~device~~ mounts are used to displace or ~~rotate~~ angularly position a member of a machine ~~by a certain angle~~ with respect to another, for example the ~~device~~ mount can be used in marble machines, machines for joinery, manipulators, etc.

Currently there are two types of chip machines: continuous treatment machines and discontinuous treatment machines.

The first (i.e. continuous treatment machines) are equipped with a treatment head or workpiece-carrying table the

position and mutual orientation of which can be modified continuously ~~through~~ by stepper motors controlled by the electronics of the machine. Machines of this type allow even very complex treatments to be carried out but, however they have drawbacks which in practice limit [[its]] their use above all [[in]] to very ~~heavy duty~~ coarse treatments. Indeed, continuous treatment machines, during operation, generally have high vibration [[s]], low chip removal and, therefore, long treatment times. Moreover, continuous treatment machines are usually very expensive and are not very strong and a limited resolution. [[(]] Usually the maximum resolution that can be obtained with a continuous treatment machine is equal to 0.001°.

Discontinuous treatment chip machines, on the other hand, are ~~realize by~~ made using Hirth ~~connection devices~~ mounts. Hirth ~~device~~ mounts ~~are realized through~~ have two identical disks, equipped with [[front]] face teeth ~~, which are~~ connected together engaging the respective teeth between them. The disks can be rotated with respect to each other before connection so as to be positioned as required by the treatment being carried out and, therefore, so as to position as desired the mechanical member connected to them, usually consisting of the workpiece-carrying table or else the treatment head. The ~~device~~ mounts of the type indicated are ~~highly~~ widely used in practice since they allow the machine members to be positioned as required for the particular treatment being carried out and the connection between the disks is

strong and precise enough to be used even for calibrated positioning.

Machines which use Hirth ~~device~~ mounts are usually strong, they are not affected by vibrations and they allow large quantities of chips to be removed at each run. However, they are not very flexible and their use becomes all the more difficult, up to the point of becoming practically impossible, when very high resolutions are desired. Indeed, the resolution which can be obtained with conventional ~~device couplings~~ mounts of this type becomes greater as the number of teeth ~~possessed by~~ on the disks (of the same type) becomes greater. This is due to the fact that the disks have the same number of teeth and, therefore, the greater the number of teeth, the greater the number of positions in which a disk of 360° is divided (the positions are defined, for example, by the ~~hollows~~ gaps between two teeth of a disk in which the teeth of the other disk ~~insert~~ engage). This necessarily implies that to obtain greater resolution and, therefore, to divide the 360° angle into many positions it is necessary to increase the number of teeth. Moreover, it must be considered that the teeth must transmit [[a]] torque and, therefore, their thickness cannot be too thin otherwise [[it]] they would be too weak and there could be the risk, if subjected to too high forces, of them breaking.

Of course, these two drawbacks combined with each other mean that in practice as the required resolution increases the diameter needed for the disks increases and, therefore, the bulk, the weight, etc. increases.

OBJECTS OF THE INVENTION

The ~~technical task proposed~~ object of the present invention is, therefore, that of realizing a ~~connection device~~ mount between members of a machine which allows the aforementioned technical drawbacks of the prior art to be eliminated.

In this technical task, an object ~~purpose~~ of the invention is ~~that of realizing~~ providing a ~~connection device~~ mount between members of a machine which is flexible and capable of working with very high resolution.

Another ~~purpose~~ object of the invention is that of ~~realizing~~ making a ~~device~~ mount which is very strong. In particular, the teeth which allow the mutual connection of the disks are very strong and must not preferably be made very thin to increase the resolution of the ~~device~~ mount.

The last but not least ~~purpose~~ object of the invention is that of ~~realizing~~ providing a ~~device~~ mount which is very light and not very bulky, in particular compared with an analogous conventional ~~device~~ mount.

SUMMARY OF THE INVENTION

These objects ~~technical task, as well as these and other purposes~~, according to the present invention are accomplished by ~~realizing~~ a ~~connection device~~ mount between members of a machine comprising at least one first and one second coupling suitable for being connected together to ~~orientate~~ position ~~said~~ the members of ~~said~~ the machine in a work position. ~~, characterized in that said~~ The first coupling comprises ~~at least one~~ first and [[one]] second

toothed elements ~~mutually mobile~~ relatively movable between an initial reference configuration and a work configuration corresponding to a predetermined orientation of ~~said~~ the members of ~~said~~ the machine, ~~said~~ the second coupling comprising at least two toothed elements fixed together with ~~said~~ the initial configuration and mutual displacement means of ~~said~~ the second coupling with respect to ~~said~~ the first coupling suitable for taking ~~said~~ the second coupling into a connection position with ~~said~~ the first coupling once ~~said~~ the work condition of ~~said~~ the first coupling has been reached in correspondence with a small relative displacement between ~~said~~ the first and second toothed elements of ~~said~~ the first coupling equal to the difference between the sum of the pitch of two or more teeth of ~~said~~ the first toothed element of ~~said~~ the first coupling and the sum of the pitch of two or more teeth of ~~said~~ the second toothed element of ~~said~~ the first coupling. ~~Other characteristics of the present invention are, moreover, defined in the other claims.~~

BRIEF DESCRIPTION OF THE DRAWING

Further characteristics and advantages of the invention shall become clear from the description of a preferred but not exclusive embodiment of the ~~connection device~~ mount between members of a machine according to the ~~finding~~ invention, where the ~~device~~ mount is illustrated for indicating and not limiting purposes in the attached drawings, wherein:

~~figure~~ FIG. 1 shows an exploded perspective view of the ~~device~~ mount according to the ~~finding~~ invention;

~~figure~~ FIG. 2 shows a perspective view of the elements of the ~~device~~ mount according to the ~~finding~~ invention; and ~~figure~~

FIG. 3 shows a side [[top]] view of two couplings coupled together.

SPECIFIC DESCRIPTION

With reference to the ~~quoted figures~~ drawing, a ~~connection device~~ mount between members 15 and 16 of a machine is shown, wholly indicated with reference numeral 1. The ~~device~~ mount 1 comprises a first and [[a]] second ~~coupling~~ couplings 2 [[,]] and 3 suitable for being connected together to ~~orientate~~ position the members 15 and 16 of the machine in work position.

In particular, the first coupling 2 comprises two toothed elements 4 [[,]] and 5 ~~mutually mobile~~ movable relative to each other between an initial reference configuration and a work configuration corresponding to a predetermined orientation of ~~said~~ the members 15 and 16 of ~~said~~ the machine. Such toothed elements 4 and 5 are connected to the members 15 and 16 of the machine which must be positioned with respect to each other.

~~figure~~ FIG. 1 represents an example of a coupling in which the reference is defined by the teeth 6 and 7 respectively of the elements 4 and which are aligned.

The second coupling 3 comprises two ~~mutually fixed~~ relatively fixed toothed elements 8 [[,]] and 9 having the initial configuration [[(]] defined by the teeth 10 and 11 aligned with each other and aligned with the teeth 6 and 7 so as to allow the mutual connection of the two couplings [[)]].

The ~~device~~ mount 1 also comprises displacement means 12 of the second coupling 3 with respect [[ively]] to the first coupling 2, suitable for taking the second coupling 3 into a connection position with the first coupling 2.

The toothed elements 4, 5, 8, and 9 are ~~constructively~~ of simple construction and are very practical to use. However, in different embodiments the couplings 2 and 3 have connection means different from ~~toothings~~ teeth such as, for example, cylindrical pins inserted in holes, etc.

Suitably, the displacement means 12 [[are]] is suitable for displacing or rotating the second coupling 3 with respect to the first coupling 2 by an amount proportional to the relative displacement of the two elements 4 [[,]] and 5 of the first coupling 2.

As shown in the attached figures, preferably the ~~mutually mobile~~ relatively movable toothed elements 4 [[,]] and 5 of the first coupling 2 have an annular configuration and are concentric and, correspondingly, the ~~mutually fixed~~ relatively fixed toothed elements 8 [[,]] and 9 of the second coupling 3 also have an annular configuration and are concentric.

Moreover, the ~~mutually mobile~~ relatively movable toothed elements 4 [[,]] and 5 of the first coupling 2 have different numbers of teeth and, at the same time, the ~~mutually fixed~~ relatively fixed toothed elements 8 [[,]] and 9 of the second coupling 3 also have different numbers of teeth. Advantageously, the inner mobile toothed elements 5 and the inner fixed toothed

elements 9 have fewer teeth than corresponding outer mobile toothed elements 4 and outer fixed toothed elements 8.

In this way, the teeth of the inner toothed elements have a large thickness (in any case greater than the case in which the teeth of the inner elements are greater in number with respect to the teeth of the outer elements) and are, therefore, very strong.

In a different example the inner mobile toothed elements 5 and the inner fixed toothed elements 9 have a greater number of teeth than corresponding outer mobile toothed elements 4 and outer fixed toothed elements 8.

Moreover, the inner mobile toothed element [[s]] 5 and the inner fixed toothed element [[s]] 9 have the same number of teeth and, in the same way, the outer mobile toothed element [[s]] 4 and the outer fixed toothed element [[s]] 8 have the same number of teeth.

In a preferred embodiment, the difference between the number of teeth of the outer mobile toothed elements 4 and of the inner mobile toothed elements 5 is greater than one and, moreover, the difference between the number of teeth of the outer fixed toothed elements 8 and of the inner fixed toothed elements 9 is greater than one.

For example, by realizing inner mobile and fixed elements equipped with 32 teeth and outer mobile and fixed toothed elements with 45 teeth, a resolution of 0.25° can be obtained.

Thus, by rotating the inner toothed element with respect to the outer toothed element of the first coupling in a certain

direction by an amount equal to such a minimum resolution, the alignment between the seventh tooth of the outer toothed element and the fifth tooth of the inner toothed element of such a first coupling is recreated, then the second coupling is rotated by 56° in the opposite direction to the direction of rotation of the inner toothed element of the first coupling so as to ~~achieve the~~ engage [[ment]] with the first coupling.

Advantageously, the machine is a chip machine and the ~~device~~ mount connects a workpiece-carrying table and/or a treatment head and/or a workpiece-carrying chuck and/or a divider to a structure of the machine.

In other examples the machine is a divider or else a machine for treating wood or marble, a grinder, a welder, a measuring instrument, machines which operate in gradual measurement, textile machines, etc. In practice, the ~~device~~ mount assembly according to the present ~~finding~~ invention can advantageously be used in whatever mechanism, even manual, [[which]] that needs to make gradual divisions.

The operation of the ~~connection device~~ mount between members 15 and 16 of a machine according to the invention is clear from that which has been described and illustrated and, in particular, is substantially the following.

Initially, the two couplings are ~~interfaced~~ meshed together and the reference elements are aligned with each other.

In practice, therefore, the two couplings are ~~interfaced~~ meshed together and the teeth 6 [[,]] and 7 of the first coupling 2

are aligned with the ~~hollow~~ gaps 13 ~~defined by~~ between the teeth 10 [[,]] and 11 of the second coupling 3. In this way the two couplings 2 [[,]] and 3 can be connected together by making them ~~translate~~ move axially toward each other along their common axis 14.

When one wishes to change the relative orientation of piece-carrying table or treatment head, the inner mobile element 5 is rotated, with respect to the outer mobile element 4, by an amount which is sufficient to position the piece-carrying table or treatment head as desired.

Then, to connect the two couplings, the second coupling 3 is rotated by a predetermined amount proportional to the rotation applied to the inner mobile element 5.

For example, the small displacement which it is possible to realize with the ~~device~~ mount assembly represented in the ~~attached figures~~ drawing is equal to 2.7272°, which is realized by aligning the teeth A and B after the teeth 7 [[,]] and 6 and by rotating the second coupling 3 by 30° in the opposite direction to align it with the first coupling 2 and to allow the connection.

In this way, the reference of the second coupling 3 (i.e. the hollow 13 defined by the aligned teeth 10 and 11 which are fixed with respect to each other) is brought back aligned with the new reference of the first coupling (i.e. with the aligned teeth A and B), making the connection between the two couplings 2 [[,]] and 3 possible.

Hereafter, some examples of ~~connection devices~~ mounts of the type indicated shall be described and they shall be compared with equivalent conventional ~~device~~ mounts.

In a first example, we want to realize a ~~device~~ mount that is able to obtain a resolution of 1° ~~degree~~.

Thus, considering an outer toothed element with 40 teeth with an angular pitch of 9° and an inner toothed element with 9 teeth with an angular pitch of 40°, and rotating the inner toothed element with respect to the outer toothed element of the first coupling in a certain direction of rotation by an amount equal to such a minimum resolution, the alignment between the ninth tooth of the outer toothed element and the second tooth of the inner toothed element of such a first coupling is recreated, then the second coupling is rotated by 81° in the same direction as the direction of rotation of the inner toothed element of the first coupling so as to ~~achieve the engagement~~ engage with the first coupling.

It must be noted that ~~the fitting between~~ meshing of the first and second ~~coupling~~ couplings is made possible by the fact that the work configuration thus obtained by the first coupling recreates the initial reference configuration of the first coupling wherein, however, in place of the teeth of the initial reference configuration, the ninth tooth of the outer toothed element and the second tooth of the inner toothed element of the first coupling are aligned.

As is clear, the minimum resolution which can be obtained is equal to the difference between the sum of the pitch of the

ninth tooth of the outer toothed element and the sum of the pitch of two teeth of the inner toothed element.

Using a conventional ~~device~~ mount toothed elements would have to be realized having an outer diameter equal to about 500 ~~millimeters~~ mm (due to the smallest possible size of the teeth for reasons of strength and the number of teeth necessary).

Using the ~~device~~ mount according to the ~~finding~~ invention, on the other hand, toothed elements having an outer diameter of about 70 ~~millimeters~~ mm are sufficient.

In a second example we want to realize a ~~device~~ mount that is able to obtain a resolution of 0.5° ~~degrees~~.

Using a conventional ~~device~~ mount toothed elements would have to be realized having [[:]] an outer diameter equal to about 500 ~~millimeters~~ mm, whereas using the ~~device~~ mount according to the ~~finding~~ invention toothed elements having an outer diameter of about 70 ~~millimeters~~ mm are sufficient.

In a third example we want to realize a ~~device~~ mount that is able to obtain a resolution of 0.25°.

Using a conventional ~~device~~ mount toothed elements would have to be realized having an outer diameter equal to about 1000 ~~millimeters~~ mm, whereas using the ~~device~~ mount according to the ~~finding~~ invention toothed elements having an outer diameter of about 100 ~~millimeters~~ mm are sufficient.

In a fourth example we want to realize a ~~device~~ mount that is able to obtain a resolution of 0.1°.

Using a conventional ~~device~~ mount toothed elements would have to be realized having an outer diameter equal to about 3000 ~~millimeters~~ mm, whereas, using the ~~device~~ mount according to the ~~finding~~ invention toothed elements having an outer diameter of about 125 ~~millimeters~~ mm are sufficient.

In a fifth example we want to realize a ~~device~~ mount that is able to obtain a resolution of 0.05°.

Using a conventional ~~device~~ mount toothed elements would have to be realized having an outer diameter equal to about 5500 ~~millimeters~~ mm, whereas using the ~~device~~ mount according to the ~~finding~~ invention toothed elements having an outer diameter of about 180 ~~millimeters~~ mm are sufficient.

In a sixth example we want to realize a ~~device~~ mount that is able to obtain a resolution of 0.01°.

Using a conventional ~~device~~ mount toothed elements would have to be realized having an outer diameter equal to about 25,000 ~~millimeters~~ mm, whereas using the ~~device~~ mount according to the ~~finding~~ invention toothed elements having an outer diameter of about 240 ~~millimeters~~ mm are sufficient.

In a seventh example we want to realize a ~~device~~ mount that is able to. obtain a resolution of 0.005°.

Using a conventional ~~device~~ mount toothed elements would have to be realized having an outer diameter equal to about 50,000 ~~millimeters~~ mm, whereas using the ~~device~~ mount according to the ~~finding~~ invention toothed elements having an outer diameter of about 500 ~~millimeters~~ mm are sufficient.

In an eighth example we want to realize a ~~device~~ mount that is able to obtain a resolution of 0.001°.

Thus, considering an outer toothed element with 625 teeth and an inner toothed element with 9 teeth, and rotating the inner toothed element with respect to the outer toothed element of the first coupling in a certain direction of rotation by an amount equal to such a minimum resolution, the alignment between the fifty-first tooth of the outer toothed element and the forty-seventh tooth of the inner toothed element of such a first coupling is recreated, then the second coupling is rotated by 29,376° in the same direction as the direction of rotation of the inner toothed element of the first coupling so as to achieve the engagement with the first coupling.

Using a conventional ~~device~~ mount toothed elements would have to be realized having an outer diameter' equal to about 250,000 ~~millimeters~~ mm, whereas using the ~~device~~ mount according to the ~~finding~~ invention toothed elements having an outer diameter of about 550 ~~millimeters~~ mm are sufficient.

In a ninth example we want to realize a ~~device~~ mount that is able to obtain a resolution of 0.0005°.

Using a conventional ~~device~~ mount toothed elements would have to be realized having an outer diameter equal to about 500,000 ~~millimeters~~ mm, whereas using the ~~device~~ mount according to the ~~finding~~ invention toothed elements having an outer diameter of about 1000 ~~millimeters~~ mm are sufficient.

In a tenth example we want to realize a ~~device~~ mount that is able to obtain a resolution of 0.0001°.

Thus, considering an outer toothed element with 3125 teeth and an inner toothed element with 1152 teeth, and rotating the inner toothed element with respect to the outer toothed element of the first coupling in a certain direction of rotation by an amount equal to such a minimum resolution, the alignment between the 963rd tooth of the outer toothed element and the 355th tooth of the inner toothed element of such a first coupling is recreated, then the second coupling is rotated by 1,109,376° in the same direction as the direction of rotation of the inner toothed element of the first coupling so as to achieve the engagement with the first coupling.

Using a conventional ~~device~~ mount toothed elements would have to be realized having an outer diameter equal to about 2,500,000 ~~millimeters~~ mm, whereas using the ~~device~~ mount according to the ~~finding~~ invention toothed elements having an outer diameter of about 2400 ~~millimeters~~ mm are sufficient.

The present ~~finding~~ invention also refers to a machine tool equipped with the ~~device~~ mount described previously.

The machine tool comprises a ~~connection device~~ mount between its members which comprises a first and a second coupling suitable for being connected with each other to mutually ~~orientate~~ position the members 15 and 16 in work position.

The first coupling comprises at least two toothed elements ~~mutually mobile~~ relatively movable between an initial

reference configuration and a work configuration corresponding to a predetermined orientation of the members 15 and 16 of the machine tool.

The second coupling comprises at least two ~~mutually fixed~~ relatively fixed toothed elements having the initial configuration and displacement means of the second coupling with respect to the first coupling suitable for taking the second coupling into a connection position with the first coupling.

In practice, it has been noted how the ~~connection device~~ mount between members 15 and 16 of a machine according to the invention is particularly advantageous because it is very precise and strong, it allows complete reproducibility, it has substantial resolution and, at the same time, it has low bulk and weight.

The ~~connection device~~ mount between members 15 and 16 of a machine thus conceived is susceptible to numerous modifications and variants, all covered by the inventive concept. Moreover, all of the details can be replaced with others which are technically equivalent.

In practice, the materials used, as well as the sizes, can be whatever, according to the requirements and the state of the art.